Table 4

Percentage Distributions of the Male Labor Force by Years of School Completed 1950 and 1960

Years of Schooling	1950	1960	Weighted Earnings by educational attainment 1962
5-6	25.7	12.8	76.6
7	29.1	30.1	91.6
8	10.8	13.8	100.0
9-11	25.5	32.5	108.3
13-15	6.3	7.6	163.3
16+	2.6	3.2	280.0

Sources: Denison, E. Why Growth Rates Differ.

The weights for Table 4 are derived as follows. For years 5-8 we use the adjusted weights for N.W. Europe p. 83. For 9-16+ we use the adjusted weights for the Netherlands p. 379. To adjust this figure back to the gross weights we use the formula

$$Y = 100 + 5/3|X - 100| \quad \text{for } X > 100$$

$$= 100 - 5/3|X - 100| \quad \text{for } X < 100$$

where X is Denison's adjsuted weights.

Table 5

Relative Prices, Changes in the Distribution of the Labor Force, and Indexes of Labor-Input per Manhour, Netherlands Males in the Netherlands Labor Force 1950-1960

School year Completed	p'	Δe
5-6	.7293	-.129
7	.8721	.01
8	.9521	.03
9-11	1.0311	.07
13-15	1.5547	.013
16+	2.6658	.006

growth ten years	.0515
annual growth	.0050

Table 6

PRIVATE DOMESTIC LABOR INPUT, 1951-1973 (CONSTANT GUILDERS of 1963)

Year	1. Private Domestic Persons Engaged (Millions)	2. Educational Attainment Per Person (Index)	3. Private Domestic Hours Per Person (Thousands Per Year)	4. Private Domestic Labor Input, Price Index	5. Private Domestic Labor Input, Quantity Index
1951	3411.	.942	48.9	.481	23058.3
1952	3367.	.946	48.6	.473	22922.1
1953	3417.	.951	48.8	.489	23475.3
1954	3483.	.956	48.8	.530	24048.7
1955	3547.	.961	48.8	.573	24613.4
1956	3602.	.966	48.8	.619	25120.3
1957	3619.	.970	48.6	.683	25261.4
1958	3580.	.975	48.6	.711	25114.4
1959	3620.	.980	48.8	.723	25627.4
1960	3692.	.985	48.8	.780	26268.1
1961	3746.	.990	46.5	.876	25523.5
1962	3825.	.995	46.5	.926	26192.4
1963	3878.	1.000	46.6	1.000	26745.8
1964	3952.	1.005	46.1	1.157	27098.9
1965	3986.	1.010	46.1	1.278	27469.0
1966	4009.	1.015	46.1	1.408	27766.0
1967	3986.	1.020	45.3	1.530	27263.6
1968	4021.	1.025	45.3	1.689	27640.8
1969	4083.	1.030	45.1	1.903	28083.2
1970	4129.	1.036	44.2	2.188	27972.4
1971	4140.	1.041	43.8	2.458	27932.4
1972	4082.	1.046	43.4	2.807	27426.3
1973	4085.	1.051	43.0	3.249	27329.8

in current prices is provided by the Nationale rekenigen. Price deflators for (1) - (4) are computed using total investment by the economy in each capital stock type, valued in constant and current dollars, as provided in the National Accounts, OECD. Real investment in consumer durables was computed from indexes found in the National Accounts, OECD and the National Accounts, Statistical Office of the European Communities. We assume the stock of land is constant, with zero investment in land in each year.

We use the deflators implicit in our investment data as estimates of the asset deflators for all assets except inventories, where the investment deflators are very erratic. We use the wholesale price index as the inventory asset deflator.

We take our benchmarks for nonresidential structures, producer durables, residential structures, and inventories in current prices from Goldsmith and Saunders.[9] We deflate these benchmarks to real values using our asset deflators. We estimate our own benchmark for consumer durables.

Replacement rates for residential structures, nonresidential structures, and producer durables was provided by the Department of National Accounts, Centraal Bureau voor de Statistiek. We estimated our own replacement rate for consumer durables. This replacement rate is the same as those used for consumer durables in other European countries.[10]

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[9] Goldsmith and Saunders (1959).

[10] See Christensen, Cummings, and Singleton (1975), Christensen, Cummings, and Norton (1975), and Brazell, Christensen, and Cummings (1975).

We compute the value of agricultural land using the quantity and rental price of agricultural land as presented in Jaarcijfers voor Nederland. Government imposed price controls kept the price of agricultural land below its market value. We therefore adjust the value of agriculture land such that it equals the 1952 estimate of Goldsmith and Saunders. The value of nonagricultural land is estimated to be 10.5% of the value of all structures. This percentage is the one estimated by Revel.[11] Since we assume that stock of land is fixed, this provides us with an implicit price deflator of land. The benchmarks, replacement rates, and deflators are summarized in Table 7. Price indexes for each asset class for the years 1951 to 1973 are given in Table 8.

[11] Revel (1967)

Table 7

Benchmarks, Rates of Replacement, and Price Indexes
Employed in Estimating Capital

Asset Class	1952 Benchmark (million 1963 guilders)	Replacement ratio	Deflator
consumer durables	5700	.2	implicit OECD[1] & OSCE[2]
nonresidential structures	21821	.03	implicit OECD
producer durables	21052	.10	implicit OECD
residential structures	27829	.02	implicit OECD
inventories	10000	0.00	investment implicit OECD asset: Wholesale price index Maandschrift[3]
land	44579	0.00	our implicit deflator

[1] OECD refers to the OECD, National Accounts.

[2] OSCE refers to the Statistical Office of the European Communities, National Accounts.

[3] Wholesale price index published in Maandschrift van het Centraal Bureau voor de Statistiek.

Table 8

ASSET PRICE INDEXES, 1951-1973

Year	1. Non-Residential Structures	2. Producer Durable Equipment	3. Inventories	4. Land	5. Residential Structures	6. Consumer Durables
1951	.603	.806	1.000	.344	.604	.936
1952	.651	.898	.980	.375	.658	.949
1953	.633	.879	.940	.395	.630	.922
1954	.676	.869	.950	.477	.653	.945
1955	.716	.888	.960	.499	.704	.958
1956	.784	.930	.990	.535	.778	.956
1957	.855	.951	1.010	.574	.861	.981
1958	.874	.960	.990	.588	.886	.980
1959	.870	.958	1.000	.617	.863	.981
1960	.885	.987	.980	.650	.878	.992
1961	.909	.972	.970	.700	.905	.993
1962	.946	.976	.980	.850	.944	.998
1963	1.000	1.000	1.000	1.000	1.000	1.000
1964	1.079	1.016	1.060	1.064	1.073	1.027
1965	1.147	1.054	1.100	1.132	1.143	1.033
1966	1.222	1.069	1.150	1.205	1.219	1.061
1967	1.258	1.066	1.160	1.229	1.232	1.062
1968	1.319	1.087	1.160	1.264	1.317	1.081
1969	1.424	1.113	1.170	1.320	1.430	1.136
1970	1.536	1.186	1.240	1.323	1.552	1.167
1971	1.684	1.311	1.250	1.465	1.751	1.270
1972	1.864	1.390	1.300	1.769	1.936	1.342
1973	2.006	1.353	1.460	2.073	2.132	1.422

We assume that the real flow of services from each type of asset is proportional to its stock. To construct an aggregate quantity index of capital input we must weight each type of real service flow by its share in the total value of capital input. Thus we must construct a service price for each asset, which when multiplied times the corresponding stock yields the value of the service flow for each type of asset. We follow Christensen and Jorgenson (1969) in the specification of capital service prices. The specification of service prices requires explicit treatment of taxes. For tax purposes the Netherlands private domestic sector can be divided into enterprises and households. The household sector is not subject to direct taxes on the capital service flow from its assets. Business enterprises however, are subject to such direct taxation. In order to take this difference into account, we must allocate the stock of residential structures and between households and business enterprises and create distinct service prices for each.

We allocate our stock of residential structures between the household and enterprise sectors base on census data. We estimate that the proportion of the value of owner-occupied residential real estate attributable to land is .33 for all years. The rest of our total land stock is allocated to enterprises.

The Nationale rekeningen provides a total figure for rent, including the imputed rent of owner-occupied structures. The percentage of structures that are owner-occupied as estimated from the census data is then used to allocate total rent to the household and enterprise sectors.

The household sector is not subject to direct taxes on the capital service flow from its assets. Indirect taxation, however, is levied on the capital service flow in the form of property taxes. The capital service price for each asset in the household sector can be expressed as

$$q_{K,t} = q_{A,t-1}r_t + q_{A,t}\delta - \left(q_{A,t} - q_{A,t-1}\right) + q_{A,t}\tau_t,$$

where $q_{K,t}$ is the service price, $q_{A,t}$ is the asset price, r_t is the rate of return or cost of capital, δ is the rate of depreciation, and τ_t is the rate of property taxation.

We assume that the rate of return is the same for all household assets. We have an estimate of property compensation for household owned residential structures and land. Thus we can equate this property compensation to the capital service price of residential structures times the lagged stock of residential structures plus the capital service price of land times the lagged stock of land. This gives us an equation where the household rate of return is the only unknown. Solving for the rate of return we have an expression in terms of property compensation, depreciation, revaluation, property taxes, and asset value, where each term is a sum for residential structures and land:

r_t = (Property compensation -- property taxes
- depreciation + revaluation)/value of
capital stock at the end of last period.

We assume that this rate of return is also applicable to owner-utilized consumer durables.

Given the rate of return for household sector assets, we can compute capital service prices for residential structures, land, and consumer durables. We construct a quantity index of household capital input as a Divisia index of the capital services for these three assets. Finally, we compute the implicit price for household sector capital input.

The derivation of capital service prices for assets held by the household sector must be modified for the business enterprise sector due to direct taxation of business property compensation. The general form for capital service price becomes

$$q_{K,t} = \left[\frac{1-u_t z_t}{1-u_t}\right] \left[q_{A,t-1} r_t + q_{A,t}\delta - \left(q_{A,t} - q_{A,t-1}\right)\right] + q_{A,t}\tau_t,$$

where u_t is the effective rate of direct taxation on business net income and z_t is the present value of depreciation allowances on a unit of new investment.[12] Depreciation allowances are different from zero only for durables and structures.

We assume that the rate of return is the same for all business assets. Thus we can equate total property compensation to the sum of each capital service price times the lagged capital stock of the corresponding asset. Substitution the capital service price formulas into this expression yields an equation where the rate of return is the only unknown. Solving for the rate of return yields the following expression:

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[12] See Hall and Jorgenson (1967), (1971) for derivation of these results.

r_t = (Property compensation -- property taxes -- direct taxes -- depreciation + revaluation)/ value of capital stock at the end of last period, where each item is a sum for all six types of business enterprise assets.

Our estimate of the effective rate of business enterprise direct taxation is obtained as the ratio of federal profit, enterprise, and corporation taxes to business property income less taxes on business property and the inputed value of depreciation allowances for tax purposes.[13] Imputed depreciation differs from depreciation for tax purposes in reflecting changes in the present value of future depreciation allowances as well as the current flow of depreciation allowances. The present value of depreciation deductions on new investment depends on depreciation formulas allowed for tax purposes, the lifetimes of assets used in calculating depreciation, and the rate of return. We assume that the rate of return used for discounting future depreciation allowances in the corporate sector is constant at ten percent. The straight line depreciation method is primarily used in the Nethèrlands. Rates are specified for a variety of asset types and industries. We have averaged the specified rates and arrived at the following estimated rates applicable to our aggregates: .03 for nonresidential structures; .10 for machinery and equipment; and .02 for residential structures.

[13] See Table 1a above for details on tax treatment.

We estimate the price of capital services for each asset employed in the business sector by substituting the business rate of return into the corresponding formula for the price of capital services. These formulas also depend on acquisition prices of capital assets, rates of replacement, and variables describing the tax structure. The quantity index of business capital input is computed as a Divisia index of the quantity of capital services for the five types of assets, where the weights are the relative shares of capital input in total business sector property compensation. Finally, we compute the implicit price for business sector capital input.

We construct the quantity index of capital input for the entire private domestic economy as a Divisia index of the quantity indexes of (1) household and (2) business enterprise capital input. The price index is computed as the ratio of total property compensation divided by the quantity index. In Table 9 we present the price and quantity indexes for capital input in the domestic business economy and for the household and business enterprises subsectors.

We construct the quantity index of total domestic business sector factor input as a Divisia index of the quantity indexes of (1) labor input and (2) capital input. The price index is computed as the ratio of total factor compensation divided by the quantity index. In Table 10 we present the price and quantity indexes of total factor input, as well as the relative share of property outlay in total factor outlay.

5. Manhour Productivity and Total Factor Productivity

The most commonly employed measure of productivity is the ratio of real

Table 9

GROSS PRIVATE DOMESTIC CAPITAL INPUT, 1951-1973 (CONSTANT GUILDERS of 1963)

Year	1. Private Domestic Capital Stock	2. Capital Input Per Unit of Capital Stock	3. Private Domestic Capital Input, Price Index	4. Private Domestic Capital Input, Quantity Index
1951	120574,6	,854	,091	103020.9
1952	124210,5	,852	,094	105770.5
1953	125155,3	,849	,094	106209.4
1954	127219,7	,853	,104	108483.5
1955	132154,8	,865	,115	114303.6
1956	137677,1	,877	,120	120762.5
1957	144149,5	,893	,118	128790.6
1958	150805,6	,909	,108	137024.8
1959	154725,7	,917	,111	141848.5
1960	159625,6	,926	,120	147858.7
1961	166488,7	,943	,116	157137.4
1962	17[illegible],9	,968	,114	168768.4
1963	181490,0	1,000	,114	181490.0
1964	188113,0	1,028	,123	193376.8
1965	198010,6	1,050	,129	207941.0
1966	207952,4	1,077	,124	223927.6
1967	217723,1	1,094	,129	238162.5
1968	228010,1	1,106	,139	252193.6
1969	239113,4	1,119	,146	267564.9
1970	251187,0	1,131	,152	284088.1
1971	265828,7	1,153	,159	306614.7
1972	278864,1	1,176	,170	327897.9
1973	290980,1	1,199	,177	348763.5

Table 10

GROSS PRIVATE DOMESTIC FACTOR INPUT, 1951-1973 (CONSTANT GUILDERS of 1963)

Year	1. Gross Private Domestic Factor Input, Price Index	2. Gross Private Domestic Factor Input, Quantity Index	3. Property Compensation Relative Share
1951	,586	33755,3	,474
1952	,611	34076,1	,480
1953	,622	34574,6	,467
1954	,679	35370,3	,469
1955	,744	36705,1	,483
1956	,787	38091,4	,482
1957	,824	39389,7	,468
1958	,809	40404,1	,454
1959	,826	41500,8	,459
1960	,893	42869,9	,465
1961	,934	43394,6	,448
1962	,958	45445,2	,443
1963	1,000	47474,2	,437
1964	1,122	49163,6	,432
1965	1,210	51123,0	,432
1966	1,262	53082,5	,416
1967	1,344	53901,5	,424
1968	1,454	55676,6	,433
1969	1,606	57625,1	,422
1970	1,769	58949,5	,413
1971	1,932	60791,0	,415
1972	2,148	61858,5	,421
1973	2.377	63333.4	.410

output to total manhours of labor input. This measure has the virtue of simplicity but the defect that it may be very poorly related to our view of increases in productivity as increases in the efficiency of the production process. A more satisfactory measure of economic efficiency is total factor productivity, the ratio of real output to a quantity index of the input of all productive factors. In Table 11 we present estimates of manhour and total factor productivity for the Netherlands economy. Manhour productivity is the ratio of our quantity index of domestic business production to total manhours. For ease of comparison we normalize this ratio to 1.0 in 1963. Total factor productivity is the ratio of our quantity indexes of domestic business production and domestic business factor input derived in Sections 3 and 4, respectively.

For purposes of comparison we also compute two alternative estimates of total factor productivity. The first variant of total factor productivity is based on the work of Denison [14], which does not take into account the impact of changes in the composition of the aggregate capital stock on factor input. Thus we compute an alternative quantity index of total factor input as a Divisia index of labor input and the aggregate capital stock. The second variant of total factor productivity is based on the work of Solow [15], which does not take into account changes in the composition of the aggregate capital stock or the labor force. Thus we compute an alternative quantity index of total factor input as a Divisia index of manhours (unadjusted for educational attainment) and capital stock. The resulting two variants of total factor productivity are presented in Table 12. It is clear that failure to account for compositional changes of labor or capital input have a substantial impact on estimates of total factor productivity.

[14] Denison (1962), (1967)

[15] Solow (1960)

TABLE 11

MANHOUR AND TOTAL FACTOR PRODUCTIVITY
1951-1973 (1963 = 1.000)

Year	1. Manhour	2. Total Factor
1951	.625	.804
1952	.641	.809
1953	.678	.859
1954	.713	.900
1955	.752	.932
1956	.781	.947
1957	.809	.949
1958	.776	.877
1959	.844	.944
1960	.897	.990
1961	.960	1.012
1962	.983	1.011
1963	1.000	1.000
1964	1.092	1.063
1965	1.151	1.087
1966	1.185	1.084
1967	1.274	1.121
1968	1.356	1.165
1969	1.435	1.204
1970	1.548	1.259
1971	1.640	1.285
1972	1.787	1.344
1973	1.895	1.381

TABLE 12

DENISON AND SOLOW VARIANTS OF TOTAL FACTOR PRODUCTIVITY, 1951-1973 (1963 = 1.000)

Year	1. Labor Services and Capital Stock	2. Man Hours and Capital Stock
1951	.748	.785
1952	.751	.729
1953	.797	.776
1954	.837	.817
1955	.872	.853
1956	.892	.876
1957	.902	.888
1958	.841	.829
1959	.908	.898
1960	.957	.949
1961	.986	.980
1962	.996	.993
1963	1.000	1.000
1964	1.076	1.079
1965	1.111	1.117
1966	1.119	1.129
1967	1.165	1.179
1968	1.217	1.234
1969	1.264	1.286
1970	1.3[illegible]7	1.354
1971	1.366	1.398
1972	1.440	1.478
1973	1.491	1.535

Returning to our preferred measurement of total factor productivity, we note that we can represent the input of capital and labor services as products of terms representing the quantity of capital and labor and the quantity of capital and labor:

$$K_s = q_K K_A, \qquad L_s = q_L L_A,$$

when K_s is the input of capital services, K_A is aggregate capital stock, L_s is the input of labor services, and L_A is the "stock" of manhours used in production. The ratios K_s/K_A and L_s/L_A indicate the quality of K_A and L_A in the sense of services provided per unit of stock. These ratios will change as a result of compositional changes in the stock. They are presented in Table 13, normalized to 1.0 in 1963 for comparison. The labor quality index of L is of course the index of educational attainment described in Section 4.

Our measure of total factor productivity assumes that production in the domestic business economy can be closely approximated by the relation

$$Y^* = A^* + \bar{W}_K K^*_S + \bar{W}_L L^*_S,$$

where Y^* is the rate of growth of gross domestic business product, A^* is the rate of growth of total factor productivity, K^*_S is the rate of growth of capital input, L^*_S is the rate of growth of labor input, $\bar{W}_K$ is the average (over two years) share of property compensation, and $\bar{W}_L$ is the average share of labor compensation. Substituting $K_S = q_K K_A$ and $L_S = q_L L_A$ into this equation yield,

TABLE 13

QUALITY OF FACTOR INPUTS, 1951-1973
(1963 = 1.000)

Year	Labor	Capital
1951	.942	.854
1952	.946	.852
1953	.951	.849
1954	.956	.853
1955	.961	.865
1956	.966	.877
1957	.970	.893
1958	.975	.909
1959	.980	.917
1960	.985	.926
1961	.990	.942
1962	.995	.968
1963	1.000	1.000
1964	1.005	1.028
1965	1.010	1.050
1966	1.015	1.077
1967	1.020	1.094
1968	1.025	1.106
1969	1.030	1.119
1970	1.036	1.131
1971	1.041	1.153
1972	1.046	1.176
1973	1.051	1.199

$$Y^* = A^* + \bar{W}_K q_K^* + \bar{W}_K K_A^* + \bar{W}_L q_L^* + \bar{W}_L L_A^*.$$

Now let us denote manhour productivity $M = Y/L_A$. We can write the rate of growth of manhour productivity as $M^* = Y^* - L_A^*$. Finally, substituting in the above expression for Y^* we have

$$M^* = A^* + \bar{W}_L q_L^* + \bar{W}_K q_K^* + \bar{W}_K \ (K_A^* - L_A^*).$$

Thus we find that total factor productivity can be considered as simply one component in manhour productivity.

Averaged over the time-period 1951-1973 Y^* is 5.3% while A^* is 2.5%. Thus our estimates imply that 53% of the growth in the Netherlands gross domestic business product is attributable to increases in total factor input, while 47% is attributable to increases in total factor productivity. The proportions of the increase in total factor input are presented in Table 14.

Finally, in Table 15 we present the average rate of growth of manhour productivity and its components. Manhour productivity has increased at an average rate of growth of 5.1% per year. Rising total factor productivity accounts for 2.5% of the total , while increases in labor quality account for .3%, increases in capital quality account for .7% and capital deepening accounts for 1.6%. We conclude that increases in total factor productivity are the most important component of observed increases in manhour productivity, but that capital deepening has also been an important factor.

Table 14

Sources of Growth in Factor Input: Quantity of Labor Input ($\bar{W}_L L^*$), Quality of Labor Input ($\bar{W}_L q_L^*$), Quantity of Capital Input ($\bar{W}_K K^*$), and Quality of Capital Input ($\bar{W}_K q_K^*$) as Proportions of the Rate of Growth of Real Factor Input.

Year	$\bar{W}_L L^*$	$\bar{W}_L q_L^*$	$\bar{W}_K K^*$	$\bar{W}_K q_K^*$
1951-1973	.048	.097	.618	.236

Table 15

Sources of Growth in Manhour Productivity (M*): Total Factor-Productivity (A*), Quality of Labor Input ($\bar{W}_L q_L^*$), Quality of Capital Input ($\bar{W}_K q_K^*$) and Capital Deepening $\bar{W}_K(K_A^* - L_A^*)$

Year	M*	A*	$\bar{W}_L q_L^*$	$\bar{W}_K q_K^*$	$\bar{W}_K(K_A^* - L_A^*)$
1951-1973	.051	.025	.003	.007	.016

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REAL PRODUCT, REAL FACTOR INPUT, AND PRODUCTIVITY IN CANADA, 1947-1973

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The measurement of social product in current and constant prices is well established in accounting practice. Official social accounts for Canada, which closely follow standard practice, are published regularly by Statistics Canada. Each delivery of social product to final demand involves a commodity or service flow that is separated into price and quantity components. Quantities and prices of individual commodities and services are combined into indexes of real product and its price or implicit deflator.

An analysis of the sources of productivity change requires the measurement of social factor outlay in current and constant prices. The conceptual basis for separation of factor outlay into price and quantity components is identical to that for social product. Each outlay on factor services must be separated into price and quantity components. Prices and quantities of the individual factor services are combined into indexes of real factor input and its price. For example, the value of labor services can be divided between the wage rate and the quantity of labor time. The product of the two is the outlay on labor services or labor compensation.

Despite the essential similarity between concepts of real product and real factor input, the measurement of social factor outlay in constant prices is not well established in social accounting practice. The chief problem is the measurement of capital input in real terms. Recently, Christensen and Jorgenson (1969) have provided a conceptual basis for measuring real capital